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Managing the life cycle of production equipment: What does it matter?

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INTRODUCTION & OBJECTIVES

- Robots are an important part of the work force in some manufacturing sectors
- The automotive industry is highly automated, especially car body shops (>90% automation)
- Automated production equipment has been used for decades, assessment of its sustainability started more recently
- Aim of this work: to assess a more environmentally friendly production practice from different perspectives, using the carbon footprint of an industrial robot installed at an automotive manufacturer as a case study

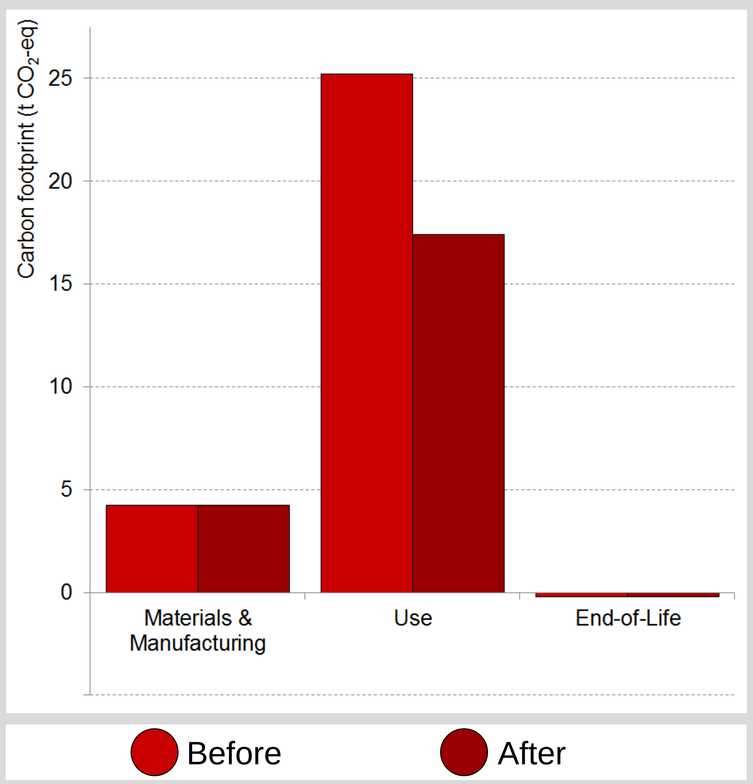
DISCUSSION & CONCLUSION

- A considerable (~25%) reduction in the carbon footprint (CF) of a robot, was found to be a minor (<0.5%) reduction in the CF of the manufactured product: the car
- Manufacturing is part of a larger system that ultimately results in meeting a market demand
- Therefore, in LCM practice for production equipment, it is recommendable to relate efforts to the manufactured product
- This approach has two advantages:
  - avoid sub-optimization of manufacturing systems and tools
  - focus efforts there, where it matters most

RESULTS: CARBON FOOTPRINTS from DIFFERENT PERSPECTIVES

Improved energy management of a typical industrial robot used in the automotive industry reduces electricity consumption

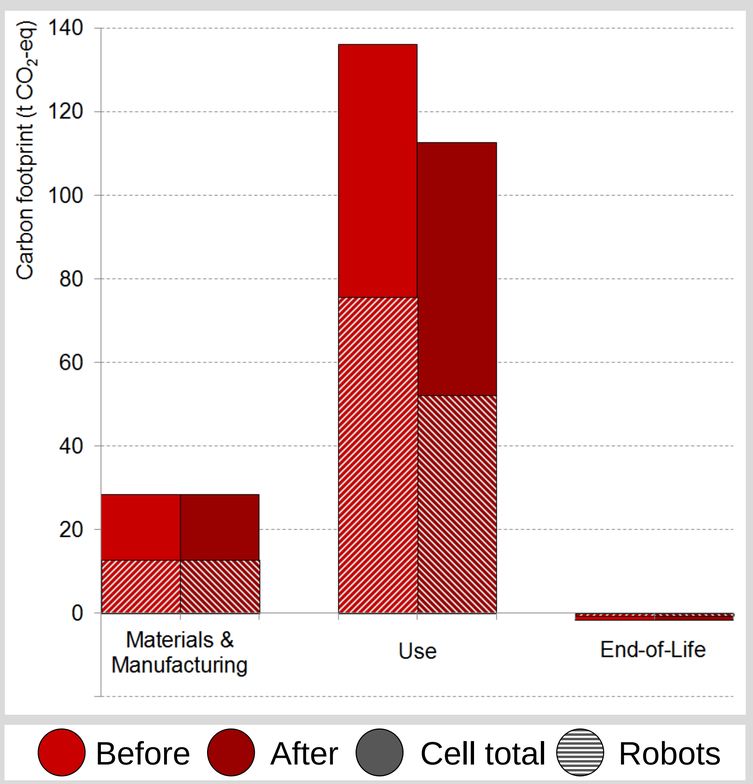
Carbon footprint of the 3 life cycle stages of a robot



From robot manufacturer's perspective:
~25% reduction in Carbon Footprint (CF) over life cycle of the robot

Zooming out: Consequences of the new robot energy management for the CF of a cell with 3 robots located in the carbody shop

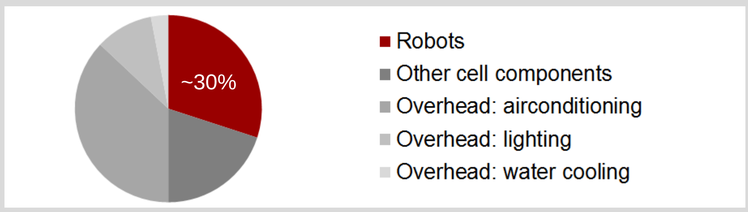
Carbon footprint of the 3 life cycle stages of a cell



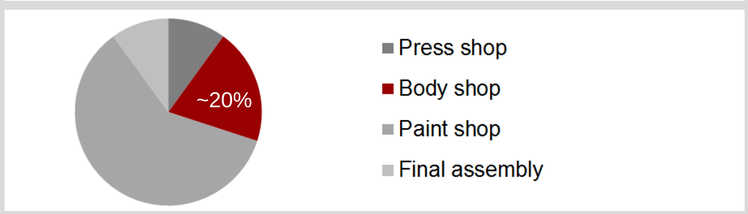
From cell operator's perspective:
~15% reduction in CF over lifetime of the cell

Zooming out even more: The body shop, where the cell is located, is part of the life cycle of the manufactured product: the car

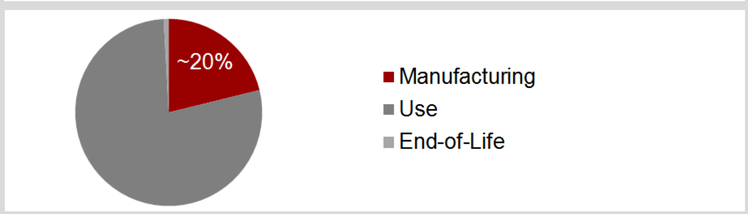
Carbon footprint of the use stage of the body shop[1]



Carbon footprint of car manufacturing[2]



Carbon footprint of a car[3] (with combustion engine)



From car producer/owner's perspective:
Improved robot energy management reduces CF over the lifetime of the car with <0.5%

METHOD

Robot and cell were modelled in GaBi 6.4, using the ecoinvent 2.2 database

	Robot	Cell
System description	Robot of 1350 kg (210 kg payload), operated in Germany in 14 weekly shifts, 48 weeks per year, for 6 years	Cell with 3 robots (2 handling, 1 clinching) + 1 gluing station operated in Germany. Same shift system and lifetime as robot
LCI – Materials & Manufacturing	Materials + masses provided by robot producer, energy for processing materials estimated	List of components provided by OEM, materials + masses estimated
LCI – Use	Typical electricity consumption + maintenance guidelines provided by robot producer	Measured electricity consumption (1 day) provided by OEM. No other processes modelled
LCI – End-of-Life	Modelled according to industrial standard for electronic waste (IEC TR 62635)	
LCIA method	IPCC Global Warming (incl. biogenic carbon), as implemented in GaBi 6.4	

Carbon footprints of body shop, car manufacturing and car: literature data

References: 1. Petrolli F (2013) Future body-in-white concepts: Increased sustainability with reduced investment and life cycle costs. Presented at AMS India Conference 2013.
2. Heil U, Paulus I, Schacht M (2014) Ganzheitlichte Betrachtung: Energie- und CO2-Reduzierung in der Herstellung der Karosserie. Presented at Karosseriebautage Hamburg 2014.
3. Mercedes-Benz (2013) Environmental Certificate Mercedes-Benz C-class.

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